Chapter Nine

Hosp Grove

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Maintenance Issues

City of Carlsbad
Community Forest Management Plan

Chapter 9 - Hosp Grove Management Plan

"…recent insect infestations…have had devastating impacts on tree health, survival, and sustainability."

This Forest Management Plan for Hosp Grove Open Space is a stand-alone chapter of the Carlsbad Community Forest Management Plan. It is addressed as an independent plan because of the Grove's unique characteristics that distinguish the Grove and its trees from typical urban trees. The Grove requires special management techniques that are utilized more often in the world of timberland forestry rather than urban forestry. Many of the techniques and strategies presented in this Management Plan can be utilized in parks and open areas that contain grove trees throughout Carlsbad.

Summary

The Hosp Grove (Grove) is a 74-acre eucalyptus forest within the northern portion of Carlsbad (Figure 3, page 32). The Grove has been heavily infested by the red gum lerp psyllid (psyllid) since 1998. Originally planted on a relatively tight planting grid nearly 100 years ago, many trees have been removed due to insect pest infestation and tree mortality. The Hosp Grove is a unique open space feature contributing to Carlsbad's identity. Over the past two years, efforts have been implemented to remove dead, dying and other poor condition trees and improve the Grove's overall condition. Still, many of the trees continue to decline due to overcrowding, drought, and insect proliferation.

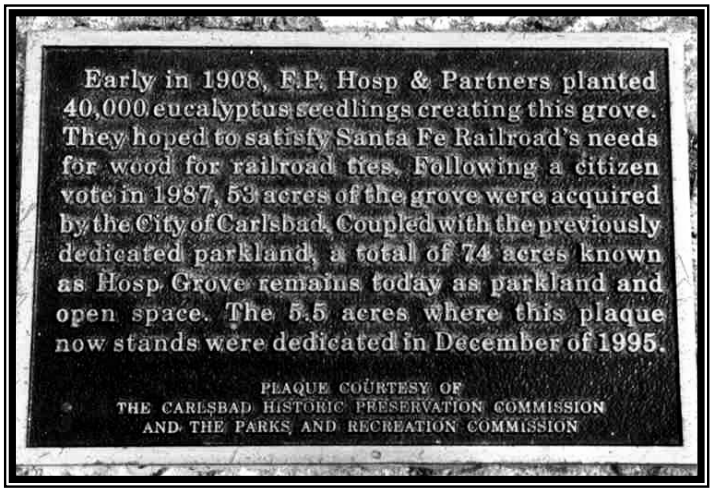
History

Like many of the eucalyptus grove plantations of southern California, Hosp Grove was originally planted for the purpose of supplying a resource where a demand was perceived. Articles from the early 1900's indicate that eucalyptus wood was in high demand for purposes such as rail ties, tool handles, buggy shafts, interior finishing and furniture—generally as a replacement for oak, mahogany and hickory. Similar plantations were planted throughout California by private companies and municipalities to create revenues and profits. A great fortune from this product was expected. The U.S. government, at the time, predicted to run out of native hardwood by the 1920's. Eucalyptus was highly praised as the solution to the government-predicted hardwood famine.

Entrepreneurs such as F.P. Hosp and others planted large tracts of eucalyptus trees. Hosp Grove originally included 40,000 trees planted by Mr. Hosp in 1908. Unfortunately for him and others, they soon found out that eucalyptus was too hard for many uses and not suitable for other expected applications because it rots relatively quickly. Because of this, the eucalyptus lumber industry did not materialize to the extent it was predicted and many groves were abandoned. For example, the nearby (*Rancho) Santa Fe* groves were abandoned in the late 1940's or 50's.

Figure 3. Hosp Grove Vicinity and Trails Map.

Many of these large eucalyptus groves continued to thrive, mainly due to the absence of natural pests. Hosp Grove was one such eucalyptus forest that thrived following abandonment. As the City of Carlsbad expanded, decision-makers recognized Hosp Grove as a unique resource that should be spared development and incorporated into the City as urban, forested open space. This final incorporation (53 acres in 1987, and most recently five and one-half acres in 1995), has been successful and includes the completion of nearly two miles of trail throughout the Grove, a playground area, and other recreational amenities.



Encompassing 74 acres, the Hosp Grove consists primarily of red and sugar gum trees *(Eucalyptus camaldulensis and E. cladocalyx).* Both species were selected for planting by Mr Hosp because they grow very fast, have very straight trunks ("stems"), and easily re-sprout from below-ground buds called lignotubers after being felled (cut down). Lignotubers in these species make them attractive for controlled harvesting. Instead of replanting a new seedling after felling a tree, the lignotuber will re-sprout and create a new tree from the old root system. The process of removing trees to encourage regrowth is called coppicing.

The Hosp Grove provides its users with a visual link to the past along with various recreation opportunities. However, recent insect infestations throughout the eucalyptus forest that comprises the Grove have had devastating impacts on tree health, survival, and sustainability. As such, this management plan provides guidelines for transitioning the Grove from a poor condition, low species diversity eucalyptus forest to a healthy, diverse, and sustainable forest. The goal of this management plan is to maintain the recreational opportunities, history, and ambiance of Hosp Grove, while providing a healthy forest that is less susceptible to large scale impacts from insects, diseases, or fire.

The following observations and expectations have become a framework for developing a multi-faceted, financially realistic, long-term management plan for Hosp Grove.

Observations

- Many of the Grove trees are 70 years old or older and are losing vigor. Because of the planting density, there are too few resources (such as available water, soil nutrients, and sunlight) to sustain the Grove in a healthy condition, especially in the presence of insect pathogens. In some areas of the Grove, competition between trees is intense.
- There is no supplemental irrigation available to the trees except to those that border adjacent residential development.
- A well-developed trail system allows users acces to many portions of the Grove. Off trail use is also prevalent.
- In high to moderate traffic areas, high soil compaction is creating limited oxygen and water availability to tree root zones.
- Red gum lerp psylla have taken a large toll on the Grove. Thousands of trees are standing

dead, referred to as “snags”, and require removal. Removal of these trees and replacement with resistant species is critical for long-term sustainability of the Grove.

- Eucalyptus long-horned borers and other detrimental pathogens were observed throughout the Grove. They typically attack trees that are experiencing stress; reducing tree stress is, therefore, important for long-term vitality.
- There is a lack of adequate signage throughout the Grove.

Expectations

- Natural and human caused pressure will continue to cause trees to be lost to insects and disease.
- Red and sugar gum trees, which together comprise 98-percent of the tree population, require 50- to 100-percent more water than they receive through annual rainfall in Carlsbad. Therefore, a combination of methods to increase the water supply in the root zone is needed, e.g. supplemental irrigation, breaking up compacted soils, and mulching. Planting drought tolerant species during the reforestation phases of this project will be critical to long term sustainability of this community Grove.
- Adequate tree spacing, soil amendments, top-mulching, irrigation, and soil fertility will improve tree health.
- Introducing age and species diversity into the Grove will improve tree health and sustainability.
- Secured funding of nearly $60,000 per year will be necessary to implement this Grove management plan.
- A part- or full- time staff person is required, along with associated equipment and vehicle, to provide planting, care, and maintenance to the Grove.

Management Program

This study was initiated to assess the eucalyptus trees that comprise the Hosp Grove Open Space in the City of Carlsbad (City) and to develop a management plan for both short- and long-term Grove improvements. This management plan is intended to serve as a framework for future planning and maintenance activities concerning the Grove. Although this study specifically addresses Hosp Grove, the maintenance guidelines may also be applicable to other eucalyptus plantings in the City. Woodbine Banks (located along El Camino Real between Tamarack Street and Chestnut Street), a 14-acre eucalyptus grove open space, is one such example. The City of Carlsbad Fire Department provides maintenance and clean-up to the Woodbine Banks area that includes access maintenance, tree trimming, and underbrush clearing.

This Management Plan centers on improving Hosp Grove (Woodbine Banks and other similarly forested areas) through a sustainable management approach. A program that maximizes the use of available natural resources, introduces species and age diversity, reduces tree stress factors, and provides an increased level of care will reinvigorate trees in this area. This comprehensive plan provides guidelines to improve the short- and long- term viability of Hosp Grove. This management strategy requires large-scale tree removal and replacement along with long-term planning to achieve many of its goals.

Establishment of a natural grove, through specific management techniques, will encourage a less dense, more sustainable stand of trees with varied tree spacing and greater age and size diversity. Initially, a large number of dead trees must be removed. For some Grove areas, the resulting tree spacing will be suitable and will not require immediate tree planting. Remaining areas that do not include a large number of dead or dying trees will require tree removals to improve tree density and spacing. Where necessary, tree thinning is recommended and will include removal of some healthy, but suppressed trees in overcrowded areas. Wider tree spacing and soil mulch cover will encourage natural production of seedlings and saplings while understory plant establishment and growth can be discouraged.

Specific objectives of this study are:

- To preserve and enhance Hosp Grove for future generations to enjoy as a visual, educational, research, and recreational amenity.
- To implement Grove management techniques that will create a more diverse, healthy, and sustainable Grove.

Methodology

Methodology for determining optimum long-term management strategies for the Grove include:

- A review of documents relating to the Hosp Grove and adjacent landscapes (see references cited at the end of this report)
- Meetings with key people, departments and groups (noted in References Cited)
- Discussions with other professionals (e.g. foresters and silviculturlists in Australia and the U.S.
- An examination and sampling of Hosp Grove

Although each of the phases of research, meetings, and discussions with other professionals is important to the success of a management program, the most important component of any forest management plan is arguably the site information gathering phase. One must have a tangible idea of the composition of a forest, including species, size, condition, and distribution in order to make sound management recommendations.

To facilitate determination of the types and quantities of trees Hosp Grove includes, the Grove was sampled using a commonly practiced technique called “plot sampling”. According to this method, the entire Grove is considered one large *stand* of trees. A stand is a continuous group of trees sufficiently uniform in species composition, age class arrangement, and health and structural conditions to be considered a homogeneous and distinguishable unit. According to this method, a desired sampling size (percentage of entire area) is predetermined in the office and sample plots are established on aerial photos or other maps of the Grove. In this study, a seven- percent sampling size was selected. Accordingly, fifty (50) plots, each measuring 1/10- acre in size were established in a random grid across the Grove. These plots were then located in the Grove during the field component of the survey, and all trees located within the plots were evaluated and recorded. Information was then processed and analyzed following fieldwork. The resulting information can be statistically extrapolated to provide a reasonably accurate representation of the Grove as a whole.

In order to make knowledgeable conclusions, the following information was recorded for each Plot within the Hosp Grove:

- Average spacing between trees
- Total number of trees
- Tree size (trunk diameter, height, canopy width)
- Live crown ratio
- Extent of sapling growth
- Percentage of multiple-trunked trees
- Health condition
- Percentage of deadwood in the canopy
- Thickness of applied mulch or duff
- Soil condition (using soil probes and core samples)
- Terrain and grade
- Slope orientation
- Direction of drainage
- Type of irrigation (if any)
- Density and composition of understory
- Traffic level, compaction and trails
- Degree of visibility through the trees
- Wildlife observed

Grove Sampling Results

Tree Species and Population Estimates

There are approximately 500 recognized species and varieties under the genus *Eucalyptus,* all but two are native to Australia. The Hosp Grove trees are almost exclusively red gum (*Eucalyptus camaldulensis*) and sugar gum (*Eucalyptus cladocalyx*), dry country eucalypts native to South Australia. Less than 2% of the trees are other species, primarily red Iron-bark (*Eucalyptus sideroxylon*) and lemon-scented Gum (*E. citriodora*). For this reason, the sugar and red gum trees are the foci of this plan. A brief discussion of each species follows.

Red Gum

The red gum is one of the best known of all eucalyptus species. It is the most widely distributed eucalypt. This is evident in its natural distribution throughout all mainland states of Australia and throughout many different areas of California, Arizona, and many Middle Eastern countries. The species includes a 23^{o} range in latitude of distribution on the earth's surface. It is known to grow in areas that receive 10- to 50- inches of rain per year. In its native habitat, the red gum is a hardy tree that adapts to a wide range of site conditions and soils. Despite its adaptability, the species grows best in soils with an assured supply of water, particularly along watercourses, especially in semi-arid areas. Well-drained, moisture retentive soils are preferred. However, the tree is fairly drought resistant once it is established.

The tree is characterized by its smooth, white to grayish

bark, lance shaped leaves, and white flowers in spring and summer. The wood is resistant to termites. It is a hardy tree in cultivation and has been used as shelter belts or windrows in arid areas. In the wetter areas of its range, red gum grows to 120 feet tall and six- feet in trunk diameter. The species displays an open canopy that is wide spreading and irregular. The root system is deep and wide spreading in suitable soils. The species has been known to tolerate alkali soils, drought, fire, frost, heat, high pH, poor soil, and water-logging. It is, however, intolerant of competing vegetation such as weeds.

Sugar Gum

The Sugar Gum is named for the sugary taste of its juvenile foliage. According to Mr. Robin Cromer (Deputy Manager of Plantations and Farm Forestry Program in Australia), the species grows best in the wetter parts of it's natural habitat, in the warm sub-humid climatic zone between latitude 30½ degrees and 36 degrees south. Temperatures in its native area range from 73- to 90- degrees Fahrenheit in the hottest months and 40- to 50-degrees Fahrenheit in the coldest months. The species withstands occasional frosts. In native stands the species is known to occur at altitudes from sea level to 2,000 feet.

In its native habitat, the Sugar Gum grows best and in denser stands in higher rainfall areas where average rainfall is twenty- and twenty six- inches a year; this species also naturally occurs in more open ranges in the drier areas where rainfall is between fifteen- and twenty-inches a year. In its natural habitat, the trees are spaced much further apart in the drier areas, spacing similar to Coast live oaks in a native woodland. In this part of Australia rainfall occurs fairly evenly throughout the year, up to 75- percent of it between the seven months of April and October (corresponding to fall, winter and spring).

The City of Carlsbad is located on similar latitude as the range of both the red and sugar gum species, namely 32 degrees north. Temperatures in Carlsbad are also similar with an average summer reading of nearly 73 degrees Fahrenheit (extreme maximum of 111 degrees) and an average winter reading of approximately 58 degrees Fahrenheit (extreme minimum of 18 degrees). However, the City of Carlsbad receives only seven- inches of rainfall a year, most of it occurring during three or four months in winter and early spring. There is only nominal rainfall May through mid-December. Although individually, the trees are able to adapt to these drier conditions, their growth habits, vitality and longevity are often compromised. With this less-than-optimal amount of water, the trees are under continual stress and therefore more susceptible to pests, diseases, and other maladies.

Red and sugar gum eucalypts grow quickly, and with adequate water, nutrients, sunlight and space, can grow up to five feet in height in a single year. Propagation (reproduction) occurs in one of two ways. Re-sprouting of new trunks from underground, healthy lignotubers is one way, and the species will also sprout from fallen seeds. In most areas within Hosp Grove, both methods are highly undesirable because of the poor condition of the existing rootstock, high tree density, minimal water available, soil compaction, and most importantly, the need to move away from a low-diversity forest.

Tree Density

Based on our survey, we estimate that there are approximately 14,451 trees within the Grove. Of these, 8,211 are red gum and 6,155 are sugar gum. Red iron bark (*Eucalyptus sideroxylon*), mostly occurring on the periphery of the Grove and associated with slope landscape planting were present with an estimated 71 trees and 14- lemon-scented gum (*Eucalyptus citriodora*) trees are present, mostly having opportunistically established from trees in neighboring landscapes.

The average number of trees per acre was calculated at just over 200 throughout the Grove. Some areas are more, some less densely stocked. For example, the original plantation grid of six- to ten-foot spacing is still evident in the Grove directly east of Monroe Street. In this area, the average number of trees per acre is much higher than the overall Grove density. Conversely, the flat area of the Grove directly north of Hosp Way contains many fewer trees per acre than the average, as this area has been subject to prior tree removal activities. On average, statistics suggest there are 115 red gum and 86 sugar gum trees per acre throughout the Grove.

Size and Structure

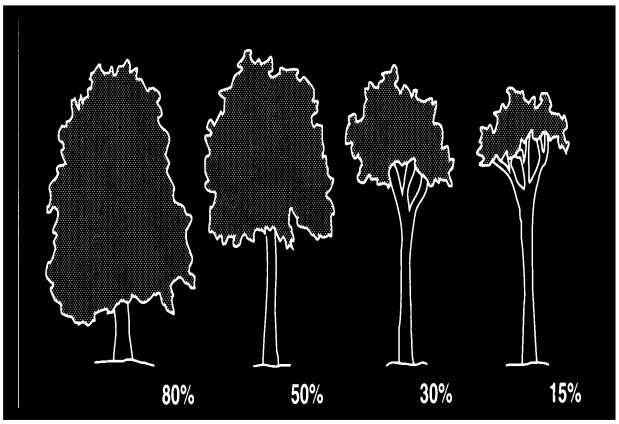
Although tall, most of the trees within Hosp Grove have not developed a substantial trunk diameter for their age. Almost 62-percent of the trees have a trunk diameter less than 10- inches, but only 27-percent of the trees are under 20- feet tall. Some 71-percent are between 21- and 60 -feet tall. Large trees (over 40 feet or greater in height and greater than 16- inches in trunk diameter) account for 25- to 30- percent of the total population. These large trees occur mainly on the edges of dense groves, along streets and buildings where there is greater spacing, and in areas adjacent to irrigated landscapes.

Trees within Hosp Grove vary from small, one- to two- inch diameter trees that are less than 20- feet tall to very large trees with diameters greater than 24- inches and heights over 60- feet. In general, the small diameter trees were dominant representing 62-percent of the tree population. An additional total of 2,500 trees with trunk diameters less than three- inches are estimated to exist within the Grove. Trees in the 10- to 16- inch diameter range account for 24- percent of the population. A relatively small percentage (14-percent) of the tree population are large trees with diameters over 17- inches. Between the two dominant species there are some differences between size distribution. There are more larger size sugar gums than red gum trees, a difference in the genetic abilities of the two species. Sugar gum tree heights throughout the Grove are generally taller than red gum on a forest level with *maximum* height for the two species very similar.

On the poorer quality sites in native Australia, red and sugar gum trees normally grow to 40- feet in height and up to 16- inch trunk diameters, similar to the trees in Hosp Grove.

In high rainfall areas, they sometimes attain 120- feet or more in height with trunk diameters of 3- to 6- feet. There are no examples of trees attaining these sizes in Hosp Grove. On good sites, the trees have clear straight trunks up to 60-percent of the tree height; in poorer sites, the trunks may be only up to 50-percent of the height and are often crooked. Canopies generally have an open appearance because the foliage is concentrated in clumps at the ends of the branches and spread over several different vertical layers of the canopy. Within the Hosp Grove, mature tree size and form is subject to the amount of water and light received driven mainly by location and tree spacing. There are scattered, mature, trees that have attained larger sizes as they out competed neighboring trees for sunlight and water.

Within portions of the Hosp Grove there is little size and age diversity. Other areas reveal good size, but poor age diversity as dominant trees have suppressed growth of same-aged, but less competitive trees. There is a large population of small and young trees, mostly re-sprouts from removed or fallen trees. Due to competition for sunlight, most of the trees have a low live crown ratio (Figure 4) and a small trunk diameter in proportion to their height. In the more densely populated areas, the ratio of foliage canopy to total tree height ("Live Crown Ratio") is fifteen- to twenty- percent. Where there is greater spacing between trees and along the Grove edges, trees have developed a more aesthetic live crown ratio of up to fifty-percent.



Trees that have minimal canopy development and small trunks in proportion to their height have a greater risk of failure (falling over). If they are within a tight grove and protected from wind by surrounding trees, this risk is minimized. However, once they are exposed to more wind as a result of removing all or some adjacent trees, the risk of tree failure can increase significantly.

Health Condition

The Hosp Grove continues to decline in both tree health and vitality. Some portions, however, appear healthier than others do. As of the Hosp Grove plot sampling, there are an estimated 5,298 dead trees within the Grove. An additional 3,513 trees were considered in poor (declining) condition. The remaining 5,012 trees were rated in fair, good, or excellent condition (2,327, 2,685, and 628 respectively). Nearly 61 percent of the trees currently in the Grove are dead or are expected to be lost due to repeated defoliation's by the lerp psyllid. This is a substantial number of trees but should not be considered devastating. The Grove was overstocked by the original planting design to get as many trees per acre as possible. Although not desirable in production tree plantations, an

occasional tree population reduction by means such as insect or disease is natural and predictable in low diversity forest settings.

The primary factors causing poor and declining tree and forest conditions includes a combination of the following:

- **Inadequate Rainfall** - These Eucalyptus species perform best when receiving approximately twice as much water (20- to 24- inches/year) as Carlsbad's average rainfall (7- to 10- inches/year).
- **Inadequate Irrigation** – The Hosp Grove is not irrigated and the species growing there require more moisture than naturally provided.
- **Pest Infestation** Repeated defoliation by a relatively new, and yet to be controlled tree defoliator, the red gum lerp psyllid – brought on by stressed, susceptible trees. May predispose trees to attack by the more lethal long horned borer.
- **Poor Spacing** - Because of the close spacing between trees, there is intense competition for available water and soil nutrients.
- **Excessive Soil Compaction** - Due to the nature of the original native soil, the soil is moderately to highly compact in most areas. Compact soils have fewer and smaller spaces between soil particles to hold water and air, both necessary for good plant health. In compact soil, rainfall runs off and does not infiltrate; so even if it rains 12-inches per year, very little of the moisture actually reaches the root systems.
- **Inadequate Soil Cover** - There is inadequate cover such as natural leaf litter or mulch, to retain moisture in the soil and moderate soil temperatures in large portions of the Grove.

Specific Health Observations

- Red gum lerp psylla are the main agent resulting in tree mortality in the Grove. The pest has caused a drastic decline in the Grove's tree population. Repeated defoliations leads to exhausted carbohydrate reserves and a highly susceptible tree. When combined with lack of irrigation, intense competition, and other tree stressors, the result may include attack by long horned borers and ultimate mortality.

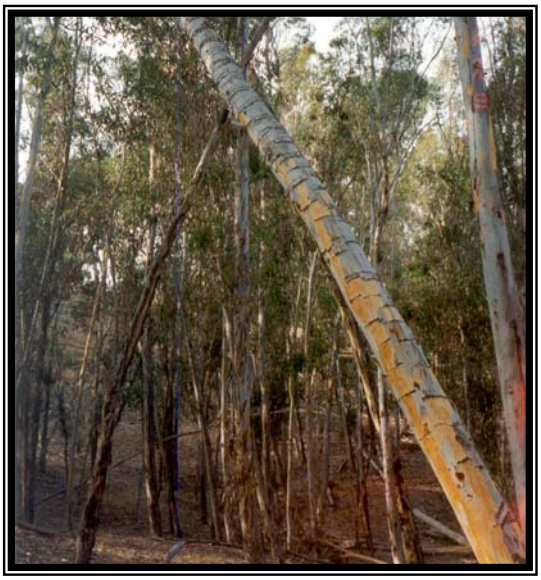
- Portions of the Grove include a higher percentage of healthy trees. These areas exist generally where the spacing is twenty feet or more (resulting in less competition for resources between trees) and there is runoff from nearby turf or landscaping – generally on the periphery of the Grove or within drainages that are incised throughout the Grove.

- The early 1990's resulted in a significant and prolonged drought period in California which continues to be felt in some portions of the state. During this drought, many

Grove trees declined in health, became more susceptible to pests and diseases, shed more branches and leaves, or were lost. Growth rings collected from trees throughout southern California indicate slow, stressed growth during this period.

- A small but significant portion of the trees have a condition known as “wetwood” or “slime flux”. Brown slimy liquid oozes from the tree’s trunk or main limbs. Often it is located at the site of an old wound. Slime flux is thought to be caused by a number of factors including a build-up of bacteria (perhaps originating in the soil) and a chemical/mineral imbalance in the tree. The oozing liquid supports many kinds of bacteria, yeasts, and fungi. It also contains acids that are quite toxic to tree tissues. When the flow persists for some time, much of the bark and cambium underneath the flow is killed.

- Some Grove trees have parallel rings of small holes around the trunk and main limbs. This is caused by woodpeckers. Excessive woodpecker damage around tree trunks or main limbs can damage trees since vascular flow is reduced. There is no indication however, that there is a correlation between woodpecker damage and die-off from beetle infestation.



Wildlife

The eucalyptus trees in Hosp Grove are not native trees to California. They have not evolved in southern California beyond approximately the last 100 years and therefore, do not provide high quality habitat value to local, native wildlife species. However, the Grove does provide certain wildlife species opportunities for shelter, open space, and foraging. Some animals are attracted to the Grove trees because of the insects, flowers, sweet sap, and cover availablity provided by the trees. Wildlife likely utilizing Hosp Grove include species common to urbanized areas of southern California. Among the animals that may be full- or part-time residents or occasional visitors of Hosp Grove are:

Hummingbird - various	insects - various
bird-of-prey - various	wood-pecker/sapsucker
roof rat	common house mouse
squirrel	Norway rat
skunk	gopher
racoon	possum
bobcats – no confirmation	fox – no confirmation
rodents - various	lizard - various

Many ground squirrel and gopher holes were observed in the Grove where the grass understory grows highest. In most areas however, the Grove density and lack of understory plants restricts the potential habitat diversity and provides only limited forage value to most local animals.

Conclusions

As previously provided, and based on our findings and analysis, the following observations and expectations have become our framework for developing a multi-faceted, financially realistic, long-term management plan for the Hosp Grove.

Observations

- Many of the Grove trees are 40 years old or older and are losing vigor. Because of the planting density, there are too few resources (such as available water, soil nutrients, and sunlight) to sustain the Grove in a healthy condition, especially in the presence of insect pathogens. In some areas of the Grove, competition between trees is intense.
- There is no supplemental irrigation available to the trees except to those that border adjacent residential development.
- There is a lack of adequate signage throughout the Grove.
- A well-developed trail system allows users access to many portions of the Grove. Off trail use is also prevalent.
- In high to moderate traffic areas, high soil compaction is creating limited oxygen and water availability to the root zones.
- Red gum lerp psylla have taken a large toll on the Grove. Thousands of trees are standing dead, referred to as “snags”, and require removal. Removal of these trees and replacement with resistant species is critical for long-term sustainability of the Grove.
- Eucalyptus long-horned borers and other detrimental pathogens were observed throughout the Grove. They typically attack trees that are experiencing stress; reducing tree stress is, therefore, important for long-term vitality.

Expectations

- Natural and human caused pressure will continue to cause trees to be lost to insects and disease.
- Red and sugar gum trees, which together comprise 98-percent of the tree population, require 50- to 100-percent more water than they receive through annual rainfall in Carlsbad. Therefore, a combination of methods to increase the water supply in the root zone is needed, e.g. supplemental irrigation, breaking up compacted soils, and mulching. Planting drought tolerant species during the reforestation phases of this project will be critical to long term sustainability of this community Grove.
- Adequate tree spacing, soil amendments, top-mulching, irrigation, and soil fertility will improve tree health.
- Introducing age and species diversity into the Grove will improve tree health and sustainability.
- Funding of nearly $60,000 per year (staffing, tree planting, monitoring, maintenance) needs to be apportioned to implement this Grove management plan.
- A part- or full- time staff person is required, along with associated equipment and vehicle, to provide planting, care, and maintenance to the Grove.

Management and Reforestation

This comprehensive plan has been prepared to improve the short- and long-term viability of the Hosp Grove while addressing needs in a fiscally prudent manner. Management and reforestation of the Grove are discussed in this section. Guidelines and recommendations for short- and long- term maintenance of the Grove are addressed in subsequent sections.

It is recommended that tree removals in Hosp Grove be conducted over a relatively short period and replanting be phased over a longer time frame. The removal of dead, dying, crowded, and suppressed trees in a timely manner will provide significant improvements to forest health while reducing potential hazards. One example that is appropriate for Hosp Grove is to utilize a system where trees are removed over a two- to four- year timeframe while areas are simultaneously replanted over a fifteen-year period. Fifteen-year planting phasing is selected because it will take approximately that long for young replacement trees at a five- gallon planted size to grow to a size considered large enough to minimize visual and other impacts. A shorter time frame for tree removal and replacement could be selected but it is not recommended that less than a ten-year time frame be used.

According to our recommended example, all dead and dying trees would be removed from the Grove during the first two- to four- years. It is important to remove the dead and dying trees for several reasons. Mainly, they:

- become reservoirs for insects and disease that can also attack nearby healthy trees.
- represent large volumes of fuel creating potential for fire hazard.
- become hazardous to people and property.
- are not consistent with a healthy reforestation plan
- provide very little benefits to wildlife.

As mentioned, there are an estimated 8,800 trees that require removal. This is a substantial number of trees and may require the assistance of private contractors. Regardless of who performs the work, removals should be coordinated with the tree planting plan so that trees are removed from areas slated for planting the following year. For example, If 2,200 trees are schedule for removal the first year (8,800 dead/dying trees divided by four years = 2,200 tree removals/year), it would be wise to remove the dead and dying, potentially hazardous trees from the playground area and other relatively high-use areas first. Approximately ¼ of the entire 74- acres would be cleared of dead and dying trees. Portions of these areas would be re-planted during the first few years' planting cycle. Replanting is discussed in detail in the following paragraph. After four years, all dead and dying trees would be removed from the Grove. Eucalyptus trees

that are in fair or good condition would not be removed unless they declined or were lost during the four years.

Replanting the Grove would occur over a time frame of 15 years. As such, approximately one-fifteenth of the Grove, or approximately 5 acres, would be replanted every year. At the end of the fifteen-year period, many of the trees in the Grove would be younger, stronger, and healthier, and there would also be increased age and species diversity. Approximately 3,000- to 5,000- red and sugar gum trees would remain throughout the Grove, providing a visual and historical "link to the past".

Depending on the level of care, the newly planted trees can be maintained in good condition for another thirty years or more before the rotation of removing and replacing trees will need to be revisited. It is plausible that the increased spacing created by this management plan will promote natural regeneration of the various species planted in the Grove. This would negate the need to remove and replant trees, but would require occasional tree thinning to maintain tree distribution and density goals. The older eucalyptus trees that are retained and integrated with new plantings will likely require on-going inspections and removal as they age and are lost.

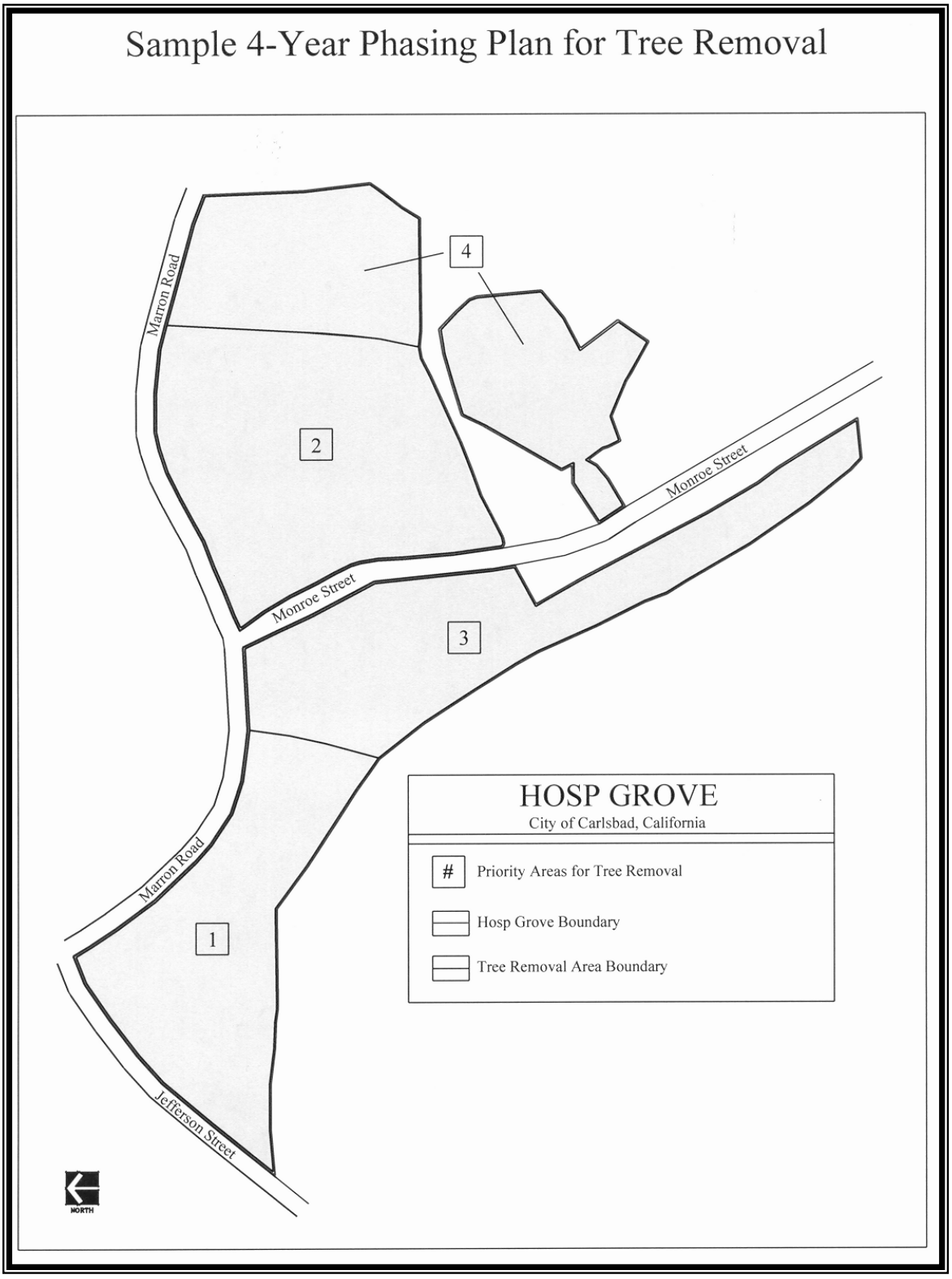
Tree Removal

Ultimately, tree removal will be necessary in most areas of Hosp Grove. Dead and dying trees will be removed as a priority. Thinning (selective tree removal) throughout the Grove may be required to promote better health in the remaining trees, even if this means that healthy trees are removed. As mentioned, tree removals are recommended for completion within the first two- to four- years. This will remove dead and dying trees, promoting better health and reducing hazards.

To minimize shading of the new seedlings by existing trees, removals and replanting should occur consecutively, adjacent to the prior phase. This will only be necessary during the first year. A tentative plan for a four-year phased tree removal is illustrated in Figure 5, page 46. Equal area for each phase was selected in order to manage cashflow, contractor labor, and appearance.

The idea is *not* to reduce the overall impact of tree removal, but to preserve the Grove and educate the public. Integral to this management strategy is an education program addressing Grove management practices. This can be accomplished by temporary signs, articles in community papers, and local radio announcements, amongst others. Prior to beginning the tree removals, a temporary notice/sign should be placed near the project area. The education program would provide information about the origin of the Hosp Grove and alleviate concerns regarding management practices, such as tree removal and irrigation.

Figure 5. Sample Phasing Plan for Tree Removals



Biomass (tree trunks, leaves, branches) from the removal trees should be used constructively throughout the Grove. Leaves, small branches, and smaller trunks can be chipped and applied as mulch or sold to companies that operate electric generating portable biomass power plants. Larger branches and tree trunks can be milled for lumber, used to delineate paths and boundaries, cut for firewood, or used for erosion control. The education program should also include information on how the removed dead and dying trees are being utilized. A practice of "zero-waste" should be adopted and communicated.

After the initial thinning, trees should be selectively removed when they have declined to an unacceptable level, typically when they die or present hazard potential beyond a level considered acceptable by the City. Competition for resources will naturally result in the more vigorous trees growing to become dominant trees. When a particular area becomes unacceptably sparse, new seedlings may need to be occasionally planted. Depending on the size of the replanting area and degree of shade from existing healthy trees, some or all of the existing trees in the replant area may need to be removed. More drought tolerant, site appropriate eucalypts and other species can be planted to improve long-term sustainability and species diversity. Suggested species can be found in the Reforestation section.

Irrigation will be necessary to establish trees and bring retained eucalyptus trees back to health. Once trees are established, the irrigation can slowly be decreased and phased out over a three- to five- year period. If irrigation is not supplied, the trees will continue to have a high degree of stress that will result in low establishment success and irregular growth patterns, shorter useful life span, and a faster decline in health and structural integrity. Irrigation may be necessary indefinitely to maintain some of the trees' health during drought periods and those on particularly dry, south or east facing slopes. Ultimately, trees species that are tolerant of Carlsbad's typical moisture regime will be established, decreasing the need for irrigation.

According to this plan, the Grove will be managed to encourage a more natural woodland character, slowly replacing the planting grid throughout the Grove. Following removal of dead and dying trees, the remaining trees should be evaluated for distribution and spacing. Where needed, the mature trees should be selectively removed to develop a random pattern with a broader range of spacing (8- to 40- feet). Selective removal techniques are discussed in the following section. At this greater spacing, a more sustainable tree density will be achieved and the individual trees comprising the Grove will be able to grow and develop a healthier and more attractive structure.

Also with wider spacing, natural production of seedlings and saplings can be encouraged. Growth of undesirable species and potentially fire hazardous plants will require diligent monitoring and removal. The greater the spacing, the larger and healthier the trees will be. A less dense, and more sustainable stand of trees will eventually evolve with greater age and size diversity, but with similar overall Grove canopy cover.

Selective Tree Removal

Selective tree removal is the removal of individual trees based on certain criteria. For Hosp Grove, trees would be selected for removal based on the following criteria, in order of priority:

- Dead
- Dying or poor health
- Structurally hazardous (e.g. split branches, severe leaning)
- Severe woodpecker damage
- Crowded (within 8-14 feet of another tree)

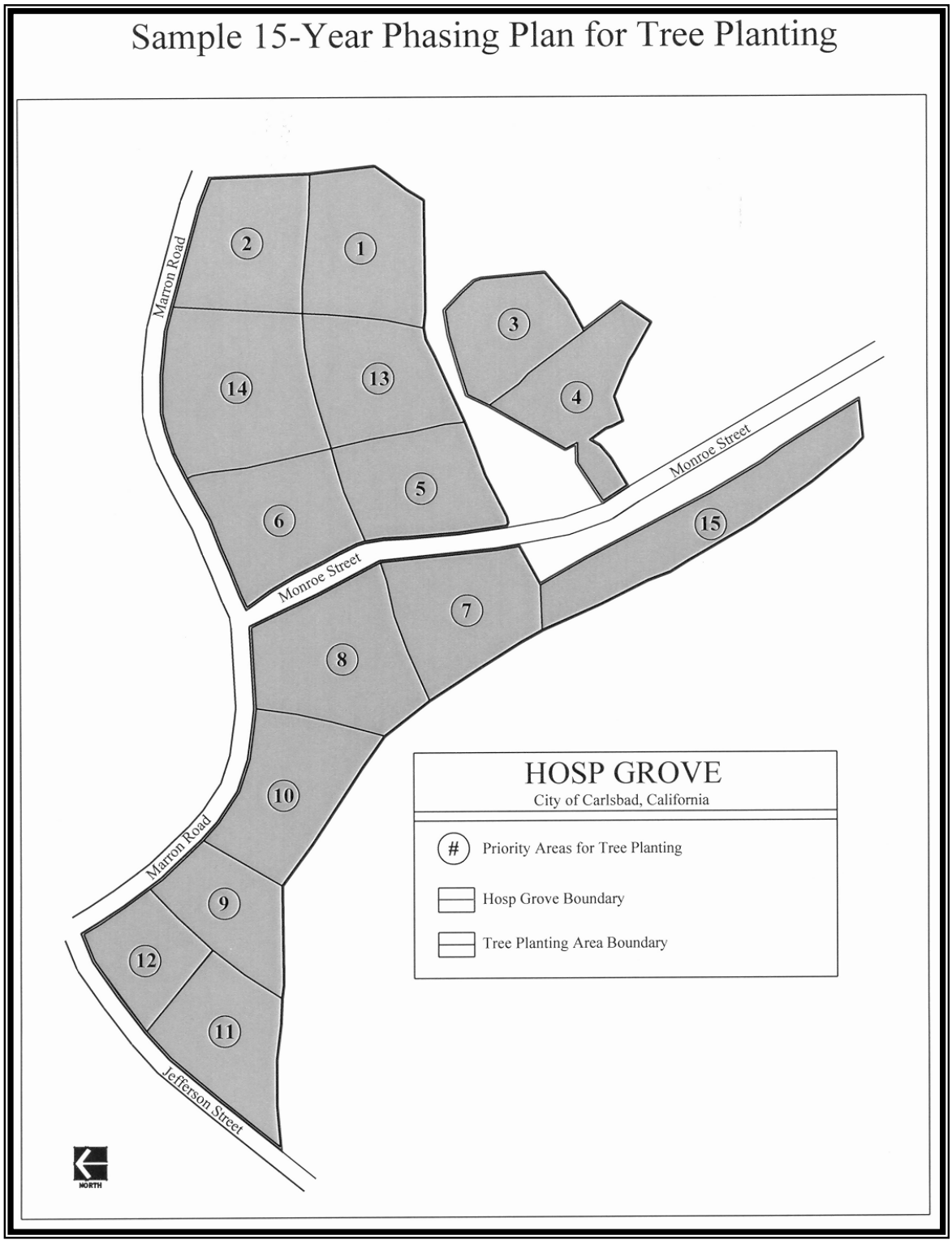
As is standard practice at the City, if a tree cannot be felled without damaging surrounding retained trees, then large branches should be cut into manageable sizes and safely lowered from the tree. The trunk should then be removed in sections and lowered to the ground, rather than letting the full height of the tree fall from the base.

Stumps should be ground to twelve inches below grade in areas where stump sprouting is undesired and equipment can safely access the stump without causing increased compaction or negative impacts to retained trees. Immediate stump grinding will help avoid undesirable stump sprout re-growth and infestation into the stumps by the Eucalyptus Longhorn Beetle. Eucalyptus plantation managers have also found that piling twelve- inches of soil over stumps minimizes sprouting. A systemic herbicide should *not* be applied over the cut or ground surface. All surface roots should be removed. Wood chips from the grinding process are to be removed and the void left by stumping backfilled with soil. The site should be returned to a safe condition.

Tree Replacement

Reforestation of Hosp Grove would include natural and supplemental tree establishment methods. Currently, openings exist that can be planted immediately. For example, the area directly north of Hosp Way (Figure 3, page 32) is an approximately five-acre, open area that could receive 200 – 400 trees immediately to take advantage of winter rains and cooler weather. As trees are removed over the first two- to four- years, there will be many available planting areas. Some areas, such as firebreaks, trails, and access points, must remain free of tree plantings to allow fire defense efforts. Figure 6, page 48 provides a tentative plan for reforestation. Adjustments may be made to the order of area reforestation based on City priorities. Following removals of dead and dying trees, and assuming that some healthy trees are removed due to overcrowding,

Figure 6. Sample Phasing Plan for Tree Planting



the anticipated per acre tree density would be approximately 50- to 60 trees per acre throughout the Grove after the fourth year. Tree planting would begin the first year and continue for fifteen consecutive years. By the end of the fifteenth year of planting trees, it is estimated that as many as 5000 trees may be planted. The resulting tree density would be approximately 75- to 120- trees per acre, a much more sustainable level than the 200 trees per acre currently on the site.

As mentioned, tree removals would leave openings in the canopy cover. This allows enough sunlight into the reforestation area to support growth of the new trees. Larger openings may have negative impacts such as visual discontinuity and growth of fire prone or high volatility fuels. A mosaic of smaller openings in the Hosp Grove will create an uneven aged forest. The original Grove was largely even-aged, resulting in an entire population that can be devastated by pests, as is currently the case. Uneven aged forests or groves include an array of age classes. When the Grove is completely planted, the overstory will have many different canopy heights, which will not only include age, size, and species diversity, it will also aid in the creation of more niches for birds and other organisms. Uneven aged management is a concept used in traditional forestry.

Planting replacement trees in small sizes, i.e., one- and five- gallon trees is recommended. The smaller trees typically surpass larger size stock in both size and vigor within a relatively short period. Anchorage development is also superior to that of fifteen- gallon and larger trees, which has a net positive effect on erosion control and tree failure. The generally accepted establishment period for the small container trees will be between three- and four-years for most species. Contract-grown, one- and five- gallon "deep-pot" container plants are recommended. On average, five-gallon trees will have a trunk caliper of ½ inch and a height of three- to four- feet; one- gallon seedlings will have a ¼ inch caliper and be two- feet tall. Trees grow more vigorously and adapt to soil conditions more rapidly when planted as small trees with healthy root systems. For natural forest re-creation, planting density should vary from 8 to 40 feet and for some species, such as oaks, multiple trees should be clustered together with clusters widely spaced. Replacement of non-surviving seedlings will be necessary. Refer to the tree selection, planting and staking specifications in Appendix C.

The planting of this natural area should be completed according to accepted practices. Namely, the trees placed in the drainages should be planted in clusters of three to four seedlings, acorns, and container trees. Because these areas may be irrigated, 1-, and 5-, gallon trees could be planted along with acorns and seedlings. When planting acorns, seedlings, or container grown trees, the first step is to ensure that the planting location is suited to the tree being planted. Slope, aspect, proximity to stream courses, proximity to developments, shade, drainage, soil type, and presence of other healthy trees are all factors to be considered when choosing a planting location for these trees. The clusters should be spaced approximately 15- to 20- feet apart such that roughly 80 planting spots per acre are supported. In the open areas, the trees should also be planted in clusters of three to four seedlings, acorns, and container trees, but the spacing should be slightly less dense, about 30- to 40- feet between tree clusters.

Note: Most of the Hosp Grove will require thinning to various degrees to open up the canopy and no or little immediate tree planting. Only some areas will require immediate replanting with new trees.

If at all possible the trees should be planted in late fall and winter in order to capture the benefits of natural rainfall and cooler temperatures. It will require more intensive maintenance to care for tree and shrubs planted during the spring and summer.

Throughout the Grove, planting other pest resistant *Eucalyptus* species and Brisbane box (*Lophostemon confertus,* formerly *Tristania conferta*) is desirable along with introduction of trees such as coast live oak (*Quercus agrifolia*), California sycamore (*Platanus racemosa*), California pepper (*Schinus molle*), and possibly Catalina ironwood (*Lyonothamnus floribundus*). Some suggested *Eucalyptus* species that have a greater drought tolerance but are similar in character to the sugar gum and have shown resistance to pests include:

- *E. saligna* – Sydney blue gum
- *E.* leucoxylon – White-iron bark
- *E. polyanthemos* - Silver Dollar Gum
- *E. sideroxylon*- Red-iron bark

Normally, non-Eucalyptus species would not be planted within the Grove. However, to introduce species diversity and to avoid large-scale tree mortality, which the Grove is currently suffering, it is recommended that non-eucalyptus species be planted throughout Hosp Grove to augment the eucalyptus species. Photographs of trees recommended for inclusion in the Hosp Grove Planting Plan are presented in the Photograph Log in Appendix D. The allelopathic affects of *Eucalypts* (inhibition of growth in one species of plants by chemicals produced by another species) must be assessed prior to replacement tree selection. The first year removal/replacement area should be considered a test plot with several species included in the planting pallet. Success and failure of individual species must be monitored and tracked in order to select species that can withstand allelopathic affects, grow in the site's soils, and are suitable for the local microclimates.

All newly planted trees will require supplemental irrigation until they are well established. The trees may require three years of light pruning to train and develop their basic framework. Trees will normally be planted with two to three stakes. These stakes should be checked annually to make sure neither the stake or tie are damaging the trees. All stakes should be removed as soon as the tree can stand upright on its own, usually one to two years is sufficient.

Planting, care and maintenance of the Grove will require a part- or full- time person to monitor irrigation and tree establishment. To complete this job, equipment including a rugged vehicle will be necessary. This is discussed further in the Operation Plan – Chapter 10 of the Carlsbad Community Forest Management Plan.

Replanting Soil Amendment

The soil should be cultivated and amended at planting time and an irrigation system extended throughout each section. If possible, the grade should be re-contoured to capture rainfall. An example is illustrated in Figure 7. It will take four years to remove all trees and fifteen years to replant the Grove, amend the soil, regrade and complete the irrigation system.

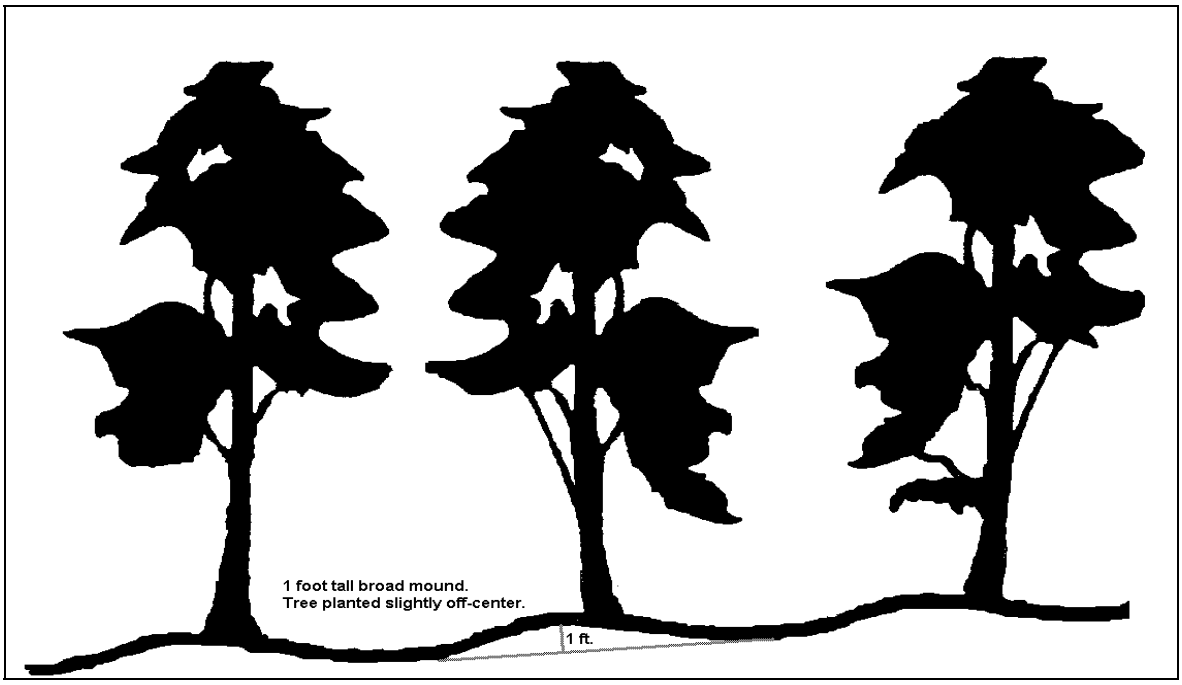


Figure 7. Tree planting swale design.

Soil conditions will need to be improved throughout portions of the Grove, most notably the degree of soil compaction will need to be reduced. One way to reduce compaction is to apply and maintain a four- inch layer of mulch. Chipped trees and tree parts from Hosp Grove would provide an on-going source for mulch material. Although the mulch will help prevent further compaction from foot traffic, it will also shift and breakdown over time. The mulch will need to be redistributed evenly over all bare soil areas; frequency will depend on traffic levels, but may be as often as every month for some portions of the Grove. Delineating pathways through the trees for foot and bicycle traffic will also help reduce compaction. Working consecutively from the bottom of the slope upward will make re-contouring for rainwater capture easier.

Soil compaction will need to be reduced via soil amendments, scarification and/or rototilling. A four- inch layer of mulch should be applied and maintained around the trees. It will be important to monitor the mulch layer as too deep a layer can result in a hostile growing environment for trees. When trees decline in these “natural” sections, they should be felled, and the branches and brush, and if equipment allows, the whole trunk should be chipped and applied to the mulch layer. Some of the logs can remain in place for natural decomposition, erosion control, and wildlife habitat where fire threat would not be increased. The threat of long-horned borer infestation of the cut logs requires that logs be left only in widely scattered locations, i.e., few and far between. The trees should be allowed to re-seed and re-sprout, thereby creating a multi-age stand

over time. Growth of understory shrubs and groundcover should be manually controlled until the canopy closure naturally reduces establishment and growth of fire prone understory plants. The trees may require periodic pruning or thinning for fire management. The next section briefly discusses some of the wildlife utilizing Hosp Grove Open Space.

Wildlife Habitat

Woodpeckers

Woodpeckers including the Yellow-bellied Sapsucker have a noticeable presence in the area. The woodpeckers use the trees for many purposes including food, food storage, and a communication device. Sapsuckers drill parallel rows of small holes in live Eucalyptus trees, then return to feed on sap and small insects. If enough holes are drilled around the circumference of a branch or a trunk, vascular flow can be inhibited causing the top of the tree or end of a branch to lose vigor. Trees used by the woodpeckers should be closely monitored. Otherwise, no other change in management practice is advised.

Other Birds

Because of their height, eucalyptus trees are often used as perching and nesting sites for many kinds of birds, including native species, hawks, and owls. Nesting activity can be encouraged in Hosp Grove by developing tall, structurally sound trees with a good live canopy. Also, the improvements in species, size, and age diversity will provide more niches for perching, nesting, foraging, and hunting opportunities.

The Migratory Bird Treaty Act protects all migratory birds and their reproduction, including sub-tropicals (e.g., swallow) and raptors (e.g., hawk). Hawks are known for nesting in eucalyptus trees. Although the full nesting season is from January to June, the critical period with respect to Hosp Grove management is from March 15 to May 30. During this time, no active nest can be removed. Furthermore, tree pruning and tree removal should not occur within 500 feet of an active nest. The U.S. Fish and Wildlife Service can levy substantial fines for transgressions. If tree pruning or removal is to occur during this time, a biologist specializing in bird of prey should be contacted to locate all active nests in the area prior to any activity.

Other Wildlife

Other local species will continue to utilize Hosp Grove opportunistically. The changes in species composition will have a net benefit for many types of wildlife. Inclusion of native trees within the Grove will provide opportunities for several native birds and mammals, along with many beneficial insects that are native to southern California.

Fire Management

Fire management at Hosp Grove is the responsibility of the City of Carlsbad Fire Department. The City has a fully functional, well-staffed regiment of fire fighters and equipment. The City operates the closest fire station with a mutual aid agreement in effect.

Current fire prevention in the Grove consists of removing dead branches, trimming off low branches and cutting tall dried annual grasses on an as-needed basis to remove surface fuel load.

California Department of Forestry and Fire Protection (CDF) provides guidelines and standards that can be used to evaluate fire risks in the Hosp Grove as well as provides prescriptive treatments and appropriate fire resistive plant lists.

Tree management in this CFMP seeks consistency with Fire management goals. As such, areas deemed important for defense against wildfire will be maintained in a state that is consistent with current uses, and where possible, improved to better meet fire department goals.

Plant Species

During periods of little rainfall, natural, non-irrigated vegetation becomes dry and highly combustible, thus increasing the potential for brush fires. When maintained without supplemental irrigation, the plants become dry, brittle and highly flammable. The shrubs are especially troublesome because they burn hotter, longer and are more difficult to extinguish. Some species contain oils and other characteristics that make them more flammable.

Grasses and low growing groundcover burn with less intensity and are easily extinguished. There is considerable annual grass and broad-leaf weeds in Grove sections that become dry throughout the summer and fall. Although highly flammable, if kept below three- inches, they will not present a serious threat.

Fire resistive plants are generally low-growing, have a low sap or resin content, grow without accumulating quantities of dead branches, needles or leaves, are easily maintained and pruned and are preferably drought tolerant. Note: there is no such thing as a plant that will not burn. All plants will burn given sufficient heat and low moisture content. Vegetative fire resistance may be enhanced through adequate irrigation or rainfall.

Understory

Some sections of the Grove include a four- to six- inch layer of annual grass growth along with scattered shrubs. However, most of the Grove does not include notable understory growth. This is because of the shade, compacted soil, foot traffic, and minimal water these areas receive. In areas where there is less foot traffic and more sunlight, there is an understory. With the removal of thousands of dead and dying trees, there is an increased likelihood of understory establishment. This growth will require careful management including trimming, above ground removal, and/or growth reduction hormones. A four- to six- inch layer of Wood-chips spread throughout the site will

also reduce understory plant establishment without increasing the fire hazard significantly. As mentioned previously in this management plan, existing young sprouts and saplings should be retained when possible for they will add to the Grove's age and size diversity. However, in areas where sapling growth is dense, the saplings will need to be culled to establish a random spacing (8- to 40- feet on center) and to reduce the likelihood of a fire ladder.

Plant Placement and Design

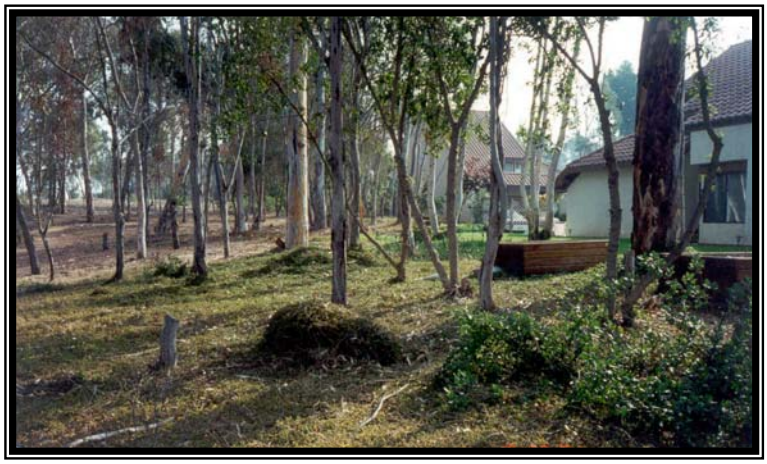
Fires spreads both horizontally (from shrub to shrub or treetop to treetop) and vertically (from shrub to tree). Greater hazards exist where the spacing between trees and between shrubs and lower branches are close enough for the fire to leap, either horizontally or vertically. In some areas of the Grove, there are horizontal fire ladders: tightly-spaced understory plants and/or intermingling tree canopies. If a fire gets in a canopy, it will quickly spread from one tree to another. In a strong fire, eucalyptus are known to produce flame lengths as tall as 100 feet.

The key is keeping the fire on the ground and preventing it from spreading into a tree canopy. Vertical ladders are prominent in portions of the Grove where the lemonade berry shrub has grown tall and dense, and in portions of the Grove where the trees have low growing branches. Although not as prominent, there may be understory, including saplings, in the Grove of sufficient size to create a fire ladder into the trees.

Although fire hazards in Hosp Grove can not be completely eliminated, they can be managed to reduce the fire risk. Identifying and managing three types of zones, 1) fire breaks, 2) fuel breaks and 3) fuel modification zones, is critical.

A *fire break* is a strip of land where all vegetation has been removed or a constructed barrier used to stop or check fires or to provide a point from which fire personnel can work. Fire breaks minimize the horizontal spread of fire from one area to another. In and around Hosp Grove, asphalt roads, parking lots, and some dirt paths can serve as effective fire breaks along with the fire breaks created by the City of Carlsbad Fire Department. These areas will help contain a fire to a section of the Grove, rather than spreading through the entire Grove.

A *fuel break* is a strategically located wide block or strip of land on which a cover of dense, heavy or flammable vegetation has been changed to one of lower fuel volume or reduced flammability as an aid to fire control. A fuel break has a low-growing groundcover to protect the soil against erosion. An example of a fuel break at Hosp Grove is adjacent, maintained turfgrass.



A *fuel modification* zone is a wide strip of land where combustible vegetation has been removed or modified or both and partially or

totally replaced with drought-tolerant, fire-resistant plants to provide an acceptable level of risk from wild land fires. Fuel modification reduces radiant and convective heat, thereby providing fire suppression forces a safer area in which to take action. It is a combination of fire resistive plants, with proper placement and maintenance.

Grove boundaries with developments ranging from residential to commercial generally provide acceptable fuel modification areas to reduce flames should they reach these areas. Types of fuel modification zones observed in the interfaces throughout the Grove perimeter include asphalt, irrigated zones, succulent plants, reduced plant density, and turf areas.

Establish fire-safe spacing in the Grove by following these guidelines:

- Keep all trees at least ten- feet away from adjacent buildings.
- Maintain a ten- foot clearance between the canopy of any tree and a building.
- Irrigate and maintain in a healthy condition all plants within fifty- feet of a building. Remove all deadwood, except as required for erosion control.
- Use ignition-resistant building materials for all new buildings and improvements within or adjacent to the Grove as addressed in the Uniform Fire Code and the Urban-Wild land Interface Code.
- Avoid massing shrubs at the base of trees and adjacent to structures; maintain a clean and clear soil space no less than 18 inches around the base of all tree trunks.
- Separate plants vertically and horizontally to prevent a fire from spreading (Figure 8). Appropriate spacing between trees and tree clumps and understory growth.

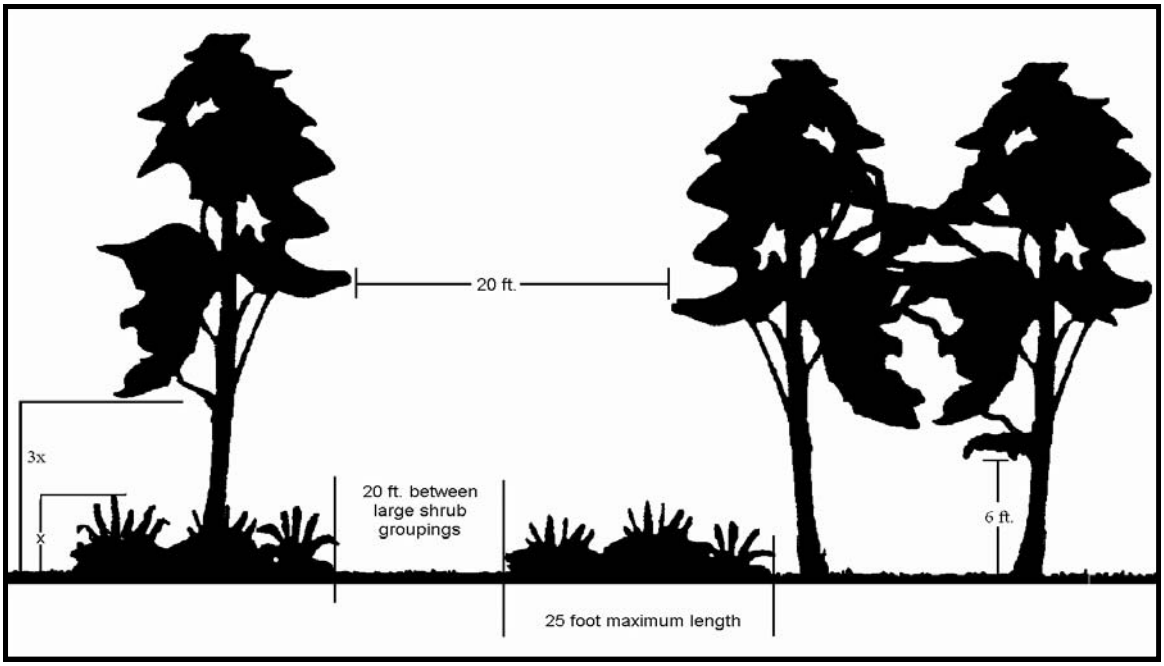


Figure 8. Appropriate spacing between trees, shrubs, and groundcover.

- Group understory shrubs in clumps measuring no more than 25- feet in length or

width; maintain a minimum twenty- (20) feet separation between shrub groupings.

- In Natural Groves with unmaintained understory, maintain at least a twenty- foot separation between tree canopy groups; three to six trees can constitute a group. This will reduce the spread of fire from treetop to treetop and create a more random spacing varying from eight- to forty- feet.
- Reduce the height of understory plants and/or remove trees (or large shrubs) lowest limbs so that the lowest part of the trees' canopy is at least three times higher than the height of the vegetation below, or six- feet, whichever is higher.
- Maintain the dirt/gravel trails, where practicable throughout the Grove in order to break-up a ground fire. The trail will need to be as wide as three times the height of the surrounding plant material.
- Where weeds are undesirable, maintaining a four- to six- inch layer of mulch over the soil will help prevent weed growth. Maintaining this layer through annual applications, will help control most of the weed problems. Unless they are competing with more desirable ornamental and native plants, weeds in natural stands should not pose a problem. To remove any unwanted weed that does germinate, hand pulling is the most effective method. Spraying pre- or post-emergents are not recommended and should not be necessary if both the soil and tree environments are healthy.

Maintenance

Maintaining trees and understories appropriately in the Grove is important for fire prevention.

- Remove dead and dying vegetation in both the understory and tree canopy. Deadwood is highly flammable.
- Logs left for habitat value in the Natural Stands should be a minimum twelve- inches in diameter and ten- feet long. Reduce all other felled tree parts to top dressing or remove from the site within 48 hours after they are cut.
- Evenly disperse chipped tree parts as understory mulch within the Grove. The mulch layer shall not exceed six inches deep. Chipped particles shall be between one- and eight- inches in length and not greater than 1½- inches in width.
- Keep grasses and weeds under six- inches in perimeter areas of the Grove, especially in the summer and fall when, without irrigation, they become brittle and dry.
- Cut stumps to less than six- inches above grade. Where stump sprouting is not desired, stumps should be ground to twelve (12) inches below grade. They should *not* be treated with an herbicide as this may kill adjacent trees.
- Keep all building roofs located within, or adjacent to the Grove, free of litter.
- Provide a water system in the non-irrigated sections, either large agricultural irrigation heads or additional fire hydrants, that can be turned on for fire suppression or fire prevention.
- All fuel powered tools and vehicles should have spark arresters. Vehicles without spark arresters should stay on paved roads.
- Maintain and make available fire suppression equipment for all personnel working within the Grove. Fire suppression equipment should consist of: one belt-type fire

extinguisher for each chainsaw operator, one 2A10BC fire extinguisher for each chipper or motorized piece of equipment, one 2½ gallon water pressurized and charged extinguisher per every four persons, one round point shovel per every two workers, and two McLeod fire tools per every two workers. A cellular telephone is required for emergency use.

Surrounding Area

Fire dangers decrease in areas surrounded by vegetation and materials that are relatively fire resistive. The Grove is largely surrounded by asphalt, concrete, or irrigated landscape. The highest fire potential from sources outside Grove boundaries exist along roads where a tossed cigarette may ignite a blaze within the Grove. Arson fire from within the Grove is also a valid concern. Because of topography, a fire started in the Grove would quickly spread uphill, provided adequate and consistent fuel. This is especially true in the Fall and early Winter when winds are more likely to reverse and blow east to west. This is also when the plants are the driest. A formula that defines attributes associated with fire danger conditions is:

low moisture content + low humidity +high temperatures = Fire Danger

Providing education to residents for maintaining fire safe landscaping is important to reduce hazards and meet goals of the City's Fire Deparement.

Grove Uses and Impacts

Park Uses

The Grove is used by many people and in many ways, some of which are:

Positive Uses

Picnicking
Children's play areas
Nature walks and retreat
Meeting places in open clearings
Hiking/jogging/walking on trails
Pet exercise

Negative Uses

Teen alcohol and drug use
Homeless loitering
Paintball games
Trash and debris dumping
Vandalism

Improving the health and vitality of the Grove along with increased presence by City personnel will result in enhancement of the positive uses of the Grove and a decline in the negative activities. Visitors should be educated on the traditional role of the Grove and proper tree practices, care and stewardship. This can be accomplished through signs, outdoor classrooms, informational messages, and literature regarding *"Trees"*.

Informal places for people to gather within the Grove should be developed such as additional or enhanced small seating areas for outdoor classroom instruction, picnic tables, and park benches. Encouraging park users to stay on paths will reduce further soil compaction.

Pedestrian traffic through the Grove is heaviest in areas where dirt paths exist. Outlying and steeper areas of the Grove are not as affected. No barriers or signage exist to encourage people (both pedestrians and bicyclists) to stay on a particular path. Trail widening and new trails are prevalent in many of the heavier used portions of the Grove. Maintaining a thick layer of mulch (4- to 6- inches) in all bare soil areas will help reduce soil compaction and improve both tree and soil health.

Visibility

High tree density, significant understory and a rolling terrain creates low Park user visibility and potential hiding/concealment sites that can pose a security and safety risk. These issues occur primarily in more remote, infrequently traveled, and naturally maintained areas.

The safety and security of people within the Grove can be further enhanced by the following:

- Supplement the map currently located at Jefferson and Marron Road intersection by installing trail maps at several trail locations – especially where paths intersect
- Improve visibility in the Grove by reducing the height of understory shrubs and removing lower branches on the trees. This will also reduce fire hazards.
- Remove any debris over two-inches in diameter from trails/paths. Mulch chips on the trails shall be under two-inches in diameter.

Tree Protection Guidelines

With the many potential activities occurring in and around the Grove, especially with regards to the tree removal and planting operations, the potential for damage to the trees is high. It is almost impossible not to affect the trees in some way. However, the ill effects of heavy equipment, tree felling, and other disturbing activities can be minimized

through proper planning. All trees should be outside of staging areas. When this is unavoidable, the following tree protection measures may be employed:

- *Erect a temporary single-strand fence and tree protection signs around trees.* The temporary fence should be four feet (4') tall flourescent webbing placed beyond the dripline at a minimum of ten feet from the trunk on all sides of all preserved trees. Tree protection signs are to be attached to the fencing every twenty feet. This will delineate the Tree Protection Zone and prevent unwanted activity in and around the trees. Preventing unwanted activity will reduce soil compaction in the root zones of the trees and other damage from heavy equipment.

- *Avoid heavy equipment operation around the trees.* Operating heavy machinery around the root zones of trees will increase soil compaction, which decreases soil aeration and subsequently reduces water penetration in the soil. All heavy equipment and vehicles should, at minimum, stay out of the Tree Protection Zone.

- *Avoid draining or leakage of equipment fluids near retained trees.* Fluids such as: gasoline, diesel, oils, hydraulics, brake and transmission fluids and glycol (anti-freeze) should be disposed of properly. Keep equipment parked or stored at least 50 feet away from retained trees to avoid the possibility of leakage of equipment fluids into the soil. The effect of toxic equipment fluids on the retained trees could lead to decline and may lead to tree death. All grounds-staff and contractors should be notified of this requirement.

- *Avoid changing grade, including adding fill, within the Tree Protection Zone.* Lowering the grade within this area will necessitate cutting main support and feeder roots, jeopardizing the health and structural integrity of the tree(s). Adding soil, even temporarily, on top of the existing grade will compact the soil further, and decrease both water and air availability to the trees' roots.

- *Remove excess debris.* Do not store supplies, materials, etc. within the Tree Protection Zone. Remove any debris from under the drip line of the trees to reduce the chances of tree decline. It is important, however, to leave the duff, mulch, chips, and leaves around the retained trees for water retention and nutrients. Keep all mulch, however, eighteen- inches from the trunk.

- *Provide supplemental irrigation system.* Irrigating the trees before, during and after construction is essential to improve tree health and decrease their susceptibility to water stress and pest infestation. One person should be designated and responsible for irrigating (deep watering) the trees and proper functioning of the irrigation system. The trees should be deep watered every ten- to twenty- days (adjust accordingly in wet winter periods). One irrigation period should thoroughly soak the root zones of the trees to a depth of three- feet. To avoid runoff and to achieve good infiltration, irrigation controllers will need to be set for repeat cycles. The soils' composition, degree of slope and weather data (can be obtained from California Irrigation Management Information System) will dictate the length of each cycle.

- Construct berms around retained trees if flood irrigating by hose or water truck. The purpose of the berm is to create a large enough water holding basin to supply the tree with sufficient water. The berms need to be a *minimum* of six- feet away from the base of a trunk. The berms should be twelve- inches in height and eighteen-

inches across.

- *Thin and corrective prune* the trees to shape, remove defects such as irregular crowns, deadwood and broken limbs, and correct any damages resulting from construction activities. All pruning should be performed under the supervision of an ISA Certified Arborist and according to ISA guidelines.

- *Plan properly for any understory.* Do not plant any plant or tree in a container size greater than five- gallon within the ten- foot protection zone as they will compete with the recovering tree for water and nutrients.

Soil Type

In their native habitats the red and sugar gum eucalypts are found on a variety of soils but perform best in skeletal or podsolic soils, frequently rather shallow. They are also found on solonized brown soils, deep sand, and on ironstone gravels. In 1973 the U.S. Department of Agriculture mapped the surficial soils in Carlsbad Hosp Grove area. The predominant soil type was found to be Carlsbad (gravelly loamy sands) and Chesterson (fine sandy loam with clayey subsoil) series. A third series, Gaviota (fine sandy loam) was also found

In order to establish additional species selected for inclusion in reforesting Hosp Grove, soil amending and improving will be required. Additionally, the allelopathic affects of eucalyptus must be tested to avoid large-scale failure of new tree plantings.

Soil Sampling

Soil sampling may be necessary for determining appropriateness of recommended tree species in the Grove. Amendments can be determined from proper sampling.

Soil conditions can be measured both by observation and quantitatively by chemical assay.
All soil samples can be sent to labs for chemical and physical analysis. The tests typically include the following:

- pH in saturated extract paste;
- electroconductivity on saturated extract;
- soluble boron, sulfate, sodium, calcium, magnesium and potassium;
- nutrients/toxic elements measurement of DTPA extract for minor elements;
- sodicity;
- soil texture and organic matter estimate;
- presence of lime determined.
- Labs also analyze samples of plant tissue (leaves) from a healthy tree, from a declining tree, and from a tree afflicted with unknown maladies. The tissue analysis provides a better picture at what the tree is actually up-taking or using in the soil.

Generally, the soil in Hosp Grove is clay-loam to sandy-loam, a fine to heavy soil subject to compaction and its related problems. It has small sized particles that are slow draining, have low aeration, and have high water and nutrient holding capacities. A high clay content soil has a low rate of infiltration with increased runoff. Clay soils are prone to problems with drainage, over-watering, limited oxygen for root development, and compaction. It holds a high content of water reducing the level of soil air and thus is susceptible to septic conditions. Plants will

typically root shallow, only to a depth of 12- to 18- inches. Fine particle soils also have a higher ability to hold ions in solution, this can lead to a more saline soil, one with a high mineral content.

Soil Erosion

Erosion was found in the Grove near heavily used sloping paths that also drain water into the canyons and bicycle paths descending from the Grove. Erosion is also common in the upper portions of drainages that cut through the Grove in several locations.

Most Grove sections have a slight to steep slope, causing water to runoff into streets, concrete paths and V-ditches. The drainage in most of the Grove is so efficient, coupled with a dense soil structure, that much of the rainfall does not infiltrate into the soil layers, but rather runs off on the surface. This exacerbates soil erosion and the trees' inability to obtain adequate amounts of water.

Soil Improvement

Although difficult and expensive to perform over large areas, a very important maintenance step that can be completed to improve the health of the trees is to *improve the physical composition and chemical stability of the soil*, including raising the soil pH and lowering the sodium and chloride levels. This will also be difficult due to the high buffering capability of clay soils. A one-time application will not solve the problem; a five- year period of annually sampling the soil, applying recommended amendments, and leaching the soil would be advised as a good practice.

Whenever possible, use the following practices to improve soil condition:

<u>Method for Areas Being Replanted</u>

- Remove trees, stumps and debris including all rocks, clods, and tree parts greater than four inches in length or diameter
- Rip the soil to a depth of 18- to 24- inches.
- Broadcast gypsum and calcium carbonate and mix into the soil with 10% organic matter and other amendments as recommended by a soil laboratory analysis.
- Rototill area to thoroughly mix in amendments and break-up particles.
- Grade and contour (if possible) to retain rainfall (previously depicted in Figure 7, page 50).
- After the irrigation system is installed and *before* planting the trees, thoroughly leach the soil to reduce sodium and salinity levels. Irrigate until field capacity is reached (puddling or runoff), wait four- to six- hours and repeat irrigation three times.
- After the trees have been planted, apply a three- to four- inch layer of mulch as a top-dressing. Although fully-composted mulch is preferred, ground greenwaste from tree removals and pruning is acceptable. The mulch should be screened at four inches or less. If possible, mulch should be kept eighteen- inches away from the base of each tree.

<u>Method for Areas with Trees in Place</u>

- After removals, thinning, pruning and fire safety work has been performed, but prior

to adding a mulch layer, evenly distribute required amounts of gypsum, calcium carbonate and other amendments as recommended in a soil laboratory analysis.

- Rototill the amendments into the top three inches of the soil staying at least two feet away from tree trunks. This process will damage some surface roots but should not affect the health or stability of the trees. Thoroughly mix.
- Note: if amendments are not added and the soil is not rototilled, break up soil compaction by scarifying four inches deep between the trees using a tractor-pulled farm implement with a hydraulic hitch, where possible. Avoid scarifying within two feet of tree trunks.
- Add a penetrant agent to the irrigation water during the leaching process. This chemical compound will help break-up the soil and increase the amount of air space.
- Thoroughly leach the soil to reduce sodium and salinity levels. This should be done in all areas by either an existing or temporary irrigation system
- Apply a four-inch layer of mulch as a top-dressing; mulch should be kept 18 inches away from the base of each tree.

Maintaining Good Soil Structure and Fertility

- Periodically leach the soil of salt buildup. The frequency will need to be based on soil tests.
- As the top-dressing mulch breaks-down (typically one inch per year), re-apply new mulch to maintain a four- inch layer.
- Correct nutrient deficiencies only by soil and tissue laboratory analysis. Do not use ammonium sulfate or other acid forming nutrients as they will further acidify the soil. Potassium nitrate (13-0-46) or calcium nitrate (15.5-0-0) can be used to increase the soil pH if not used in excess.
- Random pedestrian and bicycle traffic through the Grove should be discouraged. People should be encouraged to stay on designated paths through educational signs and path delineations. Paths have been constructed using decomposed granite with wooden headers in parts of the Grove. Additional path improvements throughout the remainder of the Grove should include similar features. The headers themselves could be milled eucalyptus from Hosp Grove removal trees.

Irrigation Management

Annually on average, Hosp Grove receives one-half the amount of rainfall (10½ inches) than the eucalyptus' native habitat in Australia (20 and 26 inches). Moreover, in Carlsbad most of the rainfall is received in a three to four month period rather than fairly evenly throughout the year in Australia (50- to 75- percent of it in a seven-month period). With this less-than-optimal amount of water, irrigation is necessary. Otherwise, the trees are under continual stress and therefore more susceptible to long-horned beetle attack, diseases and other maladies.

Because of the soil configuration in this area, water does not naturally occur in underground reservoirs at a depth where it might be available to the trees.

Irrigation System

For optimum health, all the eucalyptus trees and newly planted trees should have supplemental irrigation regardless of their spacing; even the more drought tolerant species require more than 10½- inches of water annually for optimum health. Since the Hosp Grove receives an average of 10½- inches of rainfall a year, and seventeen or more inches are needed for adequate health and growth of eucalyptus and young trees of other species, the irrigation system must provide *at least* seven inches of water a year. This should be the minimum. Irrigation needs increase in direct proportion to the number of trees per acre and the average tree size. Thus, a grove of similar-sized trees spaced twelve- feet on center will require more water than if it was spaced twenty- feet on-center. Also, larger trees require more water than smaller trees because they have more mass to sustain. Newly planted trees require more frequent irrigation for the first two to three years until fully established.

When irrigation systems are installed, the following watering schedule is recommended for the three management approaches. The amount of water indicated shall be applied *over and above the normal amount of rainfall*.

Apply eight- inches of irrigation water annually to trees in all areas. Three fourths of the supplemental water should be applied between the months of October and April. The remaining one-fourth should occur during the hot summer months. For each year, begin tracking rainfall and irrigation water applied October 1. If spring months prove to be unusually wet, less water will need to be applied during the summer.

Water should be applied slowly (to avoid run-off) to a depth of three feet and allowed to dry-out between waterings. A soil probe can help determine the amount of moisture in the soil. Because of high soil compaction a power auger may be necessary to obtain soil samples for moisture analysis at a 24" depth. Irrigation run times will depend primarily on the amount of soil compaction, slope, type of irrigation system, and head/nozzle spacing.

Water management will rely primarily on the experience of the designated staff person. Initially, it will require keen observation and sampling to determine the necessary run-times for each area. Sampling is best done using a power auger or other coring device.

Either potable or reclaimed water can be used. If reclaimed water is used, nozzles and emitters might have more frequent buildup of mineral deposits, and thus, should be inspected more frequently.

Because of expected high soil salinity throughout the Grove, initial leaching is recommended. Thereafter, leaching frequency can be recommended by soil analysis. The soil might require more frequent leaching if reclaimed water is used.

A spray irrigation system using rotor spray heads is recommended rather than a drip system mainly because it will disperse water more evenly over the entire root zone. Spray heads are also easier to inspect and maintain, are more durable and can be easily located when trenching or tilling. On the other hand, above ground spray heads will spray water on the tree trunks (a situation that can promote growth of tree attacking fungi) and are more subject to vandalism than a subsurface system. Either system will provide superior growing environments for the trees than currently available in Hosp Grove. The irrigation system to be utilized will likely include a combination of quick couplers, spaced at 150- foot intervals, supplemented as needed by hand and truck watering based on site constraints and economics.

If a non-drip system is used, Hunter rotor heads (PGM-06) or similar is recommended. Heads should be designed to pop-up 6 inches or greater in order for the water spray to clear any low growing understory and mulch layer. The selected head type, nozzle and spacing should achieve an 80 to 100% spray overlap. To avoid runoff, the spray should be low volume with repeated applications. The controller should allow for three or more repeat cycles.

In moderate to high traffic areas, risers, piping and joints should be flexible rather than the traditional PVC.

Where cost prohibits installing an irrigation system and yet supplemental water is necessary for tree health, flood irrigation using a water truck is recommended. Strategically located earthen berms can help channel, contain and evenly disperse the water.

Tree Maintenance and Trimming

After tree removal for thinning purposes, the remaining preserved trees in high traffic areas such as adjacent to trails, playground, and picnic areas should be pruned to remove deadwood, hazardous limbs, and low growing limbs (for fire safety). In highly visible areas pruning should also be done to promote a nicer looking canopy structure. "Ornamental type" character pruning and structure pruning, (not "cookie cutter") is the desired end product; trees should be pruned to accentuate their natural character as individual specimens as well as part of a group. They should *not* be pruned to look identical in shape and size.

As currently practiced by the City, International Society of Arboriculture pruning standards should be followed at all times. Refer to Appendix E for pruning specifications, illustrations regarding proper types of cuts, and description of various pruning treatments that will need to be employed. All pruning should be performed under the supervision of ISA Certified Arborists and ideally made by ISA Certified Tree Workers.

Currently, the trees in the Grove are not maintained; only dead and hazardous trees are removed. Where finances permit, the established eucalyptus trees (over 25 feet in height) should be routinely inspected and *crown cleaned* every five- to seven- years. In highly visible areas, *crown restoration* and *crown thinning* may also be needed to promote a nicer form. Trees in areas adjacent to streets will need *crown raising* for pedestrian and vehicular

clearance and fire safety. Following planting, young Grove trees should be pruned for *crown development* every year for the first four years.

Tree pruning should occur between November and March when the Eucalyptus Long-horned Borer beetle is less active. *If any tree pruning or removal activity is scheduled to be performed between January and June, the trees must be inspected for bird-of-prey nests. If active nests are found, planned activity may be limited or restricted.*

Each of the above pruning treatments can be done to different levels of detail or refinement. Except in highly visible trees, an occasional undesirable branch width of 1" or less (base diameter) may be left within the tree crown. The removal of many small branches rather than a few large branches will require more time, but will produce a less-pruned appearance, will force fewer watersprouts and will help to maintain the vitality and structure of the tree.

The trees in the Hosp Grove should never be topped. Topping (or "pollarding") is the drastic removal or cutting back of large branches using heading cuts. The tree is pruned like a hedge or rose bush; main branches are cut to stubs. Topping stimulates the regrowth of structurally unsound, dense upright branches that are more susceptible to disease and insects. Topping permanently disfigures the tree and severely depletes the tree's food-making potential. The resulting large branch stubs seldom heal leaving the tree vulnerable to insects and decay.

Waste Management

All trimmings, debris and other vegetation resulting from tree removal and trimming operations shall be promptly removed from the work site (except for top-dressing mulch) and properly disposed of.

The waste generated from these removals can be transformed into valuable products for reuse elsewhere. Small branches and leaves should be chipped and screened to a four-inch minus size and redistributed as a top-dressing mulch. Maintained at a four- to six- inch layer, this mulch will help retain water and suppress weeds. Mulch should be kept 18- inches away from all tree trunks. The raw greenwaste material can also be composted through regular hot beds or by vermiculture to create a weed and seed-free, organic soil amendment.

In Australia, Sugar Gum logs are used for pole, posts, general construction, railway sleepers and farm timber. The wood has a fine, uniform texture with interlocked grain. It is hard, heavy and of moderate strength and durability with a density about 1100 kg m^{-3}. A portable bandsaw mill and kiln (similar to the one owned and operated locally by California Department of Forestry and Fire Protection) may be appropriate for salvaging removed trees and producing useable materials. Lumber from the trees can be used throughout the City as pathway borders, signs, picnic benches and tables, furniture and other construction projects.

Pest and Disease Control

Hosp Grove eucalyptus trees, many of which will remain within the Grove throughout the removal and reforestation effort, are subject to attack from various pests and disease. The most significant of which are: Eucalyptus lerp psyllid, Long-horned borer beetle, Snout-nosed beetle, and Slime flux. Generally, trees with good vigor, low stress, adequate hydration, and proper pruning cuts will be more resistant to pests and disease. As such, the recommendations previously discussed will help improve growing environments for existing and newly established trees, reducing their level of stress and susceptibility to pests.

Red Gum Lerp and Other Eucalyptus Psyllids

There are several species of psyllid that feed on eucalyptus, the most common and most damaging being the red gum lerp psyllid (*Glycaspis brimblecombei*). First reported in Los Angeles County in 1998, the psyllid quickly spread throughout California. The psyllids, small insects that suck sap from leaves are native to Australia. Psyllids have attacked several species of eucalyptus since 1998, especially the red and sugar gum trees. The typically heavy leaf infestations cause leaf drop, branch die-back, and can lead to tree death after repeated canopy defoliation. The psyllid derives its name from the white, crystalline shell (lerp) that forms over the insect while it feeds. They often appear as black spots on the leaf due to growth of sooty mold.

Control of this insect by chemical or biological means has had mixed success. Chemical treatments have been successful in some situations, but is not recommended for large-scale projects or widespread use. Biological control, including the imported natural predator wasp (*Psyllaephagus bliteus*) has proven largely ineffective due to wasp reproduction problems.

Long-horned Beetle

First discovered in the United States in 1984 in Orange County, California, mature Eucalyptus long-horned borer beetles (*Phoracantha semipunctata and P. recurva*) lay their eggs in cracks or under loose bark. Once hatched, the larvae feed in and under the bark. This action produces tunnels that may encircle the tree completely restricting or blocking the exchange of nutrients between the roots and the leaves. This can result in the death of the tree. The larvae change to a pupae and remains 1½- to 2- inches inside the tree during the winter. Adults emerge in late April through oval-shaped holes. *Eucalyptus cladocalyx* appears to be more resistant to Long-horned borer than other eucalyptus species, namely E.globulus and E.viminalis. Additional information can be found in Appendix F.

Resistance to the beetle appears to be correlated with the level of moisture in the inner bark. Young larvae are killed as they attempt to penetrate through bark with a high moisture content, but readily mine through drier bark. Therefore, the best defense against beetle attack is to maintain healthy, well-hydrated and vigorous trees. Environmental factors and horticultural practices that cause tree stress (e.g., drought, over-crowding, nutrient deficiency, poor drainage, soil compaction, grade changes, root loss, excess irrigation, over pruning) greatly increase a tree's susceptibility to borer attack. Moreover, trees that have been well irrigated but are suddenly subject to drought appear to be at much greater risk than trees that have always grown under limited moisture conditions.

Snout-nosed Beetle

The Snout-nosed beetle (*Gonipterus scutellatus*) was discovered in March, 1994 in Ventura County. The mature beetle feeds on leaves and new shoots of Eucalyptus viminalis, E.globulus, and E.sideroxylon. The insect has not become a serious pest on a large-scale. Other eucalyptus species including E.cladocalyx are susceptible to light damage. Eggs are deposited on young leaves. After hatching, the larvae feed first on the leaf, giving the appearance of leaf miner injury, and later consume the entire young leaves and buds. Since the terminal and apical meristems are consumed, the branch(es) can not re-foliate, thereby resulting in a "witches broom" effect. Mature larvae drop from the foliage and burrow into the soil or leaf litter, to emerge as adults after the first rains.

Similar to Long-horned borer, the best defense against Snout-nosed beetle attack is to maintain healthy, well-hydrated and vigorous trees. Water must be carefully managed; drought and stress conditions avoided. Biological control of the Snout-nosed beetle is currently successful.

Slime Flux

A small portion of the Grove trees have a condition known as “wetwood” or “slime flux”. Brown slimy liquid oozes from the tree’s trunk or main limbs. Often it is located at the site of an old wound. Slime flux is thought to be caused by a number of reasons including a build-up of bacteria (perhaps originating in the soil) and a chemical/mineral imbalance in the tree. The oozing liquid supports many kinds of bacteria, yeasts, and fungi. It also contains acids that can be toxic to tree tissues. When the flow persists for some time, much of the bark and cambium underneath the flow is killed. Exact cause is unknown. No known treatments or preventative measures are known.